

## Appendix 3: Washington GHG Emissions Projection 2009-2035

In 2008, the Legislature put into law the state's GHG emissions reduction limits first adopted by Governor Gregoire in Executive Order 07-02. Washington must reduce emissions to:

- 1990 levels by 2020.
- 25 percent below 1990 levels by 2035.
- 50 percent below 1990 levels by 2050.

As part of ensuring that the state is on target to meet our statutory GHG reduction limits, the Department of Ecology (Ecology) is required to:

*Track progress toward meeting the emission reductions established in this subsection, including the results from policies currently in effect that have been previously adopted by the state and policies adopted in the future, and report on that progress. (RCW 70.235.020 (1)(b)(ii))*

In order to track progress Ecology developed a reference case projection of Washington's emissions between 2009 and 2035 if no additional actions to reduce emissions are taken. The projection is based on sector-specific energy use, population, and employment growth rates developed by federal and state government agencies. The GHG projection assumes full implementation of all existing state and federal policies to reduce GHG emissions.

### 2008-2035 GHG Emissions Trends

Ecology's projection of Washington's emissions between 2009 and 2020 predicts emissions will only grow three percent as a result of state and federal policies in place right now (Figure 1). Over the same time period, we expect state population to increase 14 percent.

Between 2020 and 2035 emissions are projected to grow an additional 10 percent. 2035 emissions are projected to be 12 percent higher than 2008 emissions. The growth in emissions is not projected to be consistent across all sectors (Table 1). State and federal policies are projected to slow the growth in emissions from energy use throughout our economy. However, there are few policies to reduce emissions in other sectors such as industrial processes and waste management. We must address emissions from these sectors if we are to meet our state emissions reduction limits.

The following paper summarizes the growth rates and data sources used to develop the Washington GHG emissions projection. Historical GHG emissions data is based on the current Washington GHG inventory.<sup>1</sup>

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<sup>1</sup> Washington State Greenhouse Gas Emissions Inventory 1990-2008.  
[www.ecy.wa.gov/biblio/1002046.html](http://www.ecy.wa.gov/biblio/1002046.html)

**Table 1. Historical and Projected GHG Emissions for Washington State**

Million Metric Tons CO <sub>2</sub> e	2008	2010	2015	2020	2025	2035
<b>Electricity, Net Consumption-based</b>	<b>19.1</b>	<b>18.8</b>	<b>18.9</b>	<b>18.4</b>	<b>18.9</b>	<b>20.4</b>
Coal	15.1	15.0	15.1	14.7	14.1	15.0
Natural Gas	3.9	3.7	3.7	3.6	4.7	5.3
Petroleum	0.1	0.1	0.1	0.1	0.1	0.1
Biomass and Waste ( CH <sub>4</sub> and N <sub>2</sub> O)	0.0	0.0	0.0	0.0	0.0	0.0
<b>Residential/Commercial/Industrial (RCI)</b>	<b>21.0</b>	<b>20.4</b>	<b>20.9</b>	<b>21.0</b>	<b>20.9</b>	<b>19.2</b>
Coal	0.3	0.2	0.3	0.2	0.2	0.5
Natural Gas	11.3	10.9	11.0	11.1	11.5	11.0
Oil	9.2	9.1	9.4	9.5	9.0	7.5
Wood (CH <sub>4</sub> and N <sub>2</sub> O)	0.2	0.2	0.2	0.2	0.2	0.2
<b>Transportation</b>	<b>45.3</b>	<b>43.3</b>	<b>44.7</b>	<b>44.9</b>	<b>45.7</b>	<b>46.8</b>
Onroad Gasoline	23.6	22.3	22.3	21.2	19.7	17.5
Onroad Diesel	9.2	8.8	9.4	9.7	10.0	11.1
Marine Vessels	3.2	3.4	3.9	4.5	5.1	6.7
Jet Fuel and Aviation Gasoline	7.8	7.4	7.7	7.9	8.2	8.6
Rail	0.9	0.9	0.9	0.9	0.9	0.9
Natural Gas, LPG	0.7	0.5	0.5	0.7	1.8	2.0
<b>Fossil Fuel Industry</b>	<b>0.7</b>	<b>0.7</b>	<b>0.6</b>	<b>0.7</b>	<b>0.7</b>	<b>0.7</b>
Natural Gas Industry(CH <sub>4</sub> )	0.7	0.7	0.6	0.7	0.7	0.7
Coal Mining (CH <sub>4</sub> )	0.0	0.0	0.0	0.0	0.0	0.0
Oil Industry (CH <sub>4</sub> )	0.0	0.0	0.0	0.0	0.0	0.0
<b>Industrial Processes</b>	<b>5.6</b>	<b>5.9</b>	<b>7.0</b>	<b>7.8</b>	<b>9.1</b>	<b>13.6</b>
Cement Manufacture (CO <sub>2</sub> )	0.4	0.4	0.3	0.3	0.3	0.3
Aluminum Production ( CO <sub>2</sub> , PFC)	2.2	2.1	2.2	1.9	1.4	1.2
Limestone and Dolomite Use (CO <sub>2</sub> )	0.0	0.0	0.0	0.0	0.0	0.0
Soda Ash	0.1	0.1	0.1	0.1	0.1	0.1
ODS Substitutes (HFC, PFC and SF <sub>6</sub> )	2.5	2.9	4.0	5.1	6.9	11.7
Semiconductor Manufacturing (HFC, PFC, SF <sub>6</sub> )	0.1	0.1	0.1	0.1	0.1	0.1
Electric Power T&D (SF <sub>6</sub> )	0.3	0.3	0.3	0.3	0.3	0.2
<b>Waste Management</b>	<b>3.9</b>	<b>4.1</b>	<b>4.6</b>	<b>5.2</b>	<b>5.8</b>	<b>7.3</b>
Solid Waste Management	3.3	3.4	3.9	4.4	4.9	6.3
Wastewater Management	0.7	0.7	0.7	0.8	0.9	1.0
<b>Agriculture</b>	<b>5.9</b>	<b>5.9</b>	<b>6.0</b>	<b>6.0</b>	<b>6.1</b>	<b>6.2</b>
Enteric Fermentation	2.3	2.3	2.3	2.3	2.3	2.2
Manure Management	1.0	1.0	1.1	1.2	1.3	1.6
Agriculture Soils	2.7	2.6	2.6	2.5	2.5	2.4
<b>Total Gross Emissions (third decimal rounding)</b>	<b>101.1</b>	<b>99.1</b>	<b>102.7</b>	<b>104.0</b>	<b>107.2</b>	<b>114.2</b>

## Electricity Sector

The reference case projection calculates GHG emissions produced to generate all of the electricity consumed in Washington. Load growth projections were supplied by the Northwest Power and Conservation Council from modeling used to develop the 6<sup>th</sup> Power Plan. Load growth assumes all cost-effective conservation as defined by the Power Council and is summarized in Table 2.

**Table 2. Annual Electricity Consumption Growth Rates.**

	Compound Annual Growth Rate (CAGR)
2010-2015	0.08%
2015-2020	-0.21%
2020-2025	0.12%
2025-2030	0.64%
2030-2035	0.64%

Much of Washington's electricity is generated from hydropower. The amount of electricity produced by the hydroelectric system fluctuates annually depending on weather patterns. The emissions projection assumes average fossil fuel generation GHG emissions from 2004-2008 as the baseline in order to account for annual variability. Emissions from existing resources were assumed to grow at the same rate as total electricity demand, adjusted for new generation as described below.

The Northwest Power and Conservation Council also supplied an estimate of new resources for the region. Much of these new generating units are expected to utilize renewable resources in order to satisfy regional Renewable Portfolio Standard (RPS) requirements. The Council also projects the addition of some natural gas fired power plants in order to meet future energy demand.

According to the Power Council 42 percent of new resources will be renewable and 58 percent will be combined cycle natural gas plants. We assumed that Washington electricity customers use their proportionate share of new resources based on the ratio of total projected Washington electricity consumption to that of the whole Northwest Power Council region.

## Transportation

### On-road Vehicle Emissions

On-road gasoline and diesel emissions were projected using the Washington Department of Transportation June 2010 vehicle miles traveled (VMT) forecast. The percentage of VMT driven

by heavy duty vehicles was assumed to remain constant at current levels (11 percent). The VMT forecast was adjusted to meet the per capita VMT reduction benchmarks for light-duty vehicles.

The ethanol blend in gasoline was assumed to increase to 10 percent and remain constant. Gasoline and diesel consumption were then adjusted based on the Energy Information Administration 2010 Annual Energy Outlook (AEO 2010) projection of total light-duty and heavy duty vehicle stock fuel efficiency, which includes the updated federal CAFE standards.

Tables 3, 4, and 5 summarize key assumption and annual growth rates used for on-road vehicle emissions.

**Table 3. Key Assumptions and Methods for the Transportation Inventory and Projections**

<b>Vehicle Type and Pollutants</b>	<b>Methods</b>
<b>Onroad gasoline, diesel, natural gas, and LPG vehicles – CO<sub>2</sub></b>	<b>Reference Case Projections (2009 – 2035)</b> Gasoline and diesel fuel projected using VMT projections provided by WSDOT adjusted by fuel efficiency improvement projections from AEO 2010. Other on-road fuels projected using Pacific Region fuel consumption projections from EIA AEO 2010 adjusted using state-to-regional ratio of population growth.
<b>Onroad gasoline and diesel vehicles – CH<sub>4</sub> and N<sub>2</sub>O</b>	<b>Reference Case Projections (2008 – 2035)</b> VMT projections from WSDOT allocated to vehicle types using vehicle specific growth rates from AEO 2010.
<b>Non-highway fuel consumption (jet aircraft, gasoline-fueled piston aircraft, boats, locomotives) – CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O</b>	<b>Reference Case Projections (2008 – 2035)</b> Aircraft projected using aircraft operations projections from FAA. No growth assumed for rail diesel. Marine fuels projected based on historical data.

**Table 4. Compound Annual Growth Rates for On-road Gasoline and Diesel CO<sub>2</sub> Emissions**

<b>Fuel</b>	<b>2009-2010</b>	<b>2010-2015</b>	<b>2015-2020</b>	<b>2020-2025</b>	<b>2025-2030</b>	<b>2030-2035</b>
On-road Gasoline	-4.5%	0.2%	-0.9%	-1.5%	-1.4%	-1.2%
On-road Diesel	-0.8%	1.4%	0.7%	0.7%	0.9%	1.0%

**Table 5. Washington Vehicle Miles Traveled Compound Annual Growth Rates**

<b>Vehicle Type</b>	<b>2008-2010</b>	<b>2010-2015</b>	<b>2015-2020</b>	<b>2020-2025</b>	<b>2025-2030</b>	<b>2030-2035</b>
Heavy Duty Diesel Vehicle	-1.8%	2.4%	1.8%	1.3%	1.1%	1.1%
Heavy Duty Gasoline Vehicle	-1.5%	-0.1%	-0.5%	0.4%	0.9%	1.4%
Light Duty Diesel Truck	-5.0%	-3.5%	2.4%	8.3%	9.1%	5.6%
Light Duty Diesel Vehicle	-5.0%	-3.5%	2.4%	8.3%	9.1%	5.6%
Light Duty Gasoline Truck	-1.8%	1.4%	0.7%	-0.1%	-0.4%	-0.5%
Light Duty Gasoline Vehicle	-1.8%	1.4%	0.7%	-0.1%	-0.4%	-0.5%
Motorcycle	-1.8%	1.4%	0.7%	-0.1%	-0.4%	-0.5%

## Aviation

Emissions for jet fuel were projected from 2009 to 2035 using commercial aircraft operations and emissions for aviation gasoline were projected from 2009-2035 using general aviation operations from the Federal Aviation Administration's Terminal Area Forecast System<sup>2</sup> and national aircraft fuel efficiency forecasts from AEO 2010. To estimate changes in jet fuel consumption, itinerant aircraft operations from air carrier, air taxi/commuter, and military aircraft were first summed for each year of interest. Estimates were adjusted to reflect the projected increase in national aircraft fuel efficiency (indicated by increased number of seat miles per gallon), as reported in AEO 2010. Because AEO 2010 does not estimate fuel efficiency changes for general aviation aircraft, forecast changes in aviation gasoline consumption were based solely on the projected number of itinerant general aviation aircraft operations in Washington. The resulting compound annual average growth rates are displayed in Table 6.

**Table 6. Washington Aviation Fuels Compound Annual Growth Rates**

<b>Fuel</b>	<b>2009-2010</b>	<b>2010-2015</b>	<b>2015-2020</b>	<b>2020-2025</b>	<b>2025-2030</b>	<b>2030-2035</b>
Jet Fuel	-2.4%	1.0%	0.6%	0.6%	0.5%	0.5%
Aviation Gasoline	-1.2%	0.7%	0.8%	0.9%	0.9%	0.9%

<sup>2</sup> Terminal Area Forecast, Federal Aviation Administration, <http://www.apo.data.faa.gov/main/taf.asp>.

## Rail

The historic data for rail shows no significant positive or negative trend; therefore, no growth was assumed for this sector.

## RCI

Reference case projections from direct fuel combustion for 2009-2035 were estimated based on fuel consumption forecasts from EIA's AEO 2010, with adjustments for Washington's projected population<sup>3</sup> and employment growth. Washington employment data for the manufacturing (goods producing) and non-manufacturing (commercial or services providing) sectors were obtained from the Washington Office of Financial Management Forecasting Division. Regional employment data for the same sectors were obtained from EIA for the EIA's Pacific region.<sup>4</sup>

Table 7 shows projected growth rates for energy use by sector and fuel type.

**Table 7. Projected Average Annual Growth in Energy Use in Washington, by Sector and Fuel**

	2008-2010	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035
<b>Residential</b>						
natural gas	0.3%	-0.4%	-0.1%	-0.3%	-0.8%	-0.9%
petroleum	-1.9%	-4.0%	-3.2%	-3.0%	-3.0%	-2.7%
Wood	-4.7%	-0.6%	-0.1%	-0.7%	-0.5%	-0.4%
Coal	-2.5%	-3.4%	-2.7%	-2.9%	-2.9%	-2.8%
<b>Commercial</b>						
natural gas	1.5%	-1.4%	-1.0%	-0.3%	-0.6%	-0.2%
petroleum	-8.5%	-0.9%	1.5%	-1.0%	-1.1%	-0.3%
Wood	1.3%	-1.5%	-1.2%	-1.0%	-1.0%	-0.7%
Coal	-3.7%	-0.4%	-1.2%	-1.0%	-1.0%	-0.7%
<b>Industrial</b>						
natural gas	-4.4%	-2.3%	-2.4%	1.8%	-1.4%	-2.3%
petroleum	-0.8%	-0.8%	0.9%	-0.4%	-1.7%	-1.8%
Wood	0.6%	0.6%	0.6%	0.3%	-0.8%	-1.5%
Coal	-7.1%	0.6%	-0.5%	-0.6%	-1.6%	16.0%

<sup>3</sup> Population data from the State of Washington, Office of Financial Management, Forecast of the State Population, November 2006 Release (<http://www.ofm.wa.gov/pop/stfc/default.asp>).

<sup>4</sup> AEO2006 employment projections for EIA's Pacific region obtained through special request from EIA.

# Industrial Processes

Table 8 lists the data sources used to quantify activities related to industrial process emissions, the annual compound growth rates implied by estimates of future activity used, and the years for which the reference case projections were calculated.

**Table 8. Industrial Process Emissions Projection Assumptions and Compound Annual Growth Rates**

Source Category	Time Period	Projection Assumptions	Data Source	Annual Growth Rates (%)					
				2008 to 2010	2010 to 2015	2015 to 2020	2020 to 2025	2025 to 2030	2030 to 2035
Cement Manufacturing - Clinker Production	2009 - 2035	Compound annual growth rate in employment for Washington's nonmetallic mineral products sector. Assume permanent closure of the LaFarge plant in 2011.	Washington State Office of Financial Management employment projections.	-5.9%	2.9%	0.2%	0.2%	0.1%	0.1%
Limestone and Dolomite Consumption	2008 - 2035	Compound annual growth rate in employment for Washington's nonmetallic mineral products sector.	Washington State Office of Financial Management employment projections.	-5.9%	2.9%	0.2%	0.2%	0.1%	0.1%
Aluminum Production	2009 - 2035	Compound annual growth rate in employment for Washington's primary metals sector.	Washington State Office of Financial Management employment projections.	-7.2%	2.8%	-3.7%	-4.8%	-4.9%	-4.9%
Soda Ash Consumption	2008 - 2035	Historical growth rate between 1990 and 2007.	WA GHG Inventory	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
ODS Substitutes	2008 - 2035	EPA SGIT national growth rate.	EPA State Inventory tool Projection Module.	9.6%	6.8%	5.4%	5.4%	5.4%	5.4%
Semiconductor Manufacturing	2008 - 2035	EPA SGIT national growth rate.	EPA State Inventory tool Projection Module.	2.8%	2.5%	2.2%	2.2%	2.2%	2.2%
Electric Power T&D Systems	2008 - 2035	EPA SGIT national growth rate.	EPA State Inventory tool Projection Module.	-0.6%	-0.6%	-0.7%	-0.7%	-0.7%	-0.7%

# Fossil Fuel Fugitive Emissions

Table provides an overview of data sources and approach used to project future emissions.

**Table 9. Approach to Projecting Methane Emissions from Natural Gas and Oil Systems**

Source Category	Time Period	Projection Assumptions	Data Source	Annual Growth Rates (%)					
				2008 to 2010	2010 to 2015	2015 to 2020	2020 to 2025	2025 to 2030	2030 to 2035
Natural Gas Transmission	2009 - 2035	Emissions are held flat at 2008 levels as there are no new transmissions pipelines undergoing permitting.	N/A	0%	0%	0%	0%	0%	0%
Natural Gas Distribution	2009 - 2035	AEO 2010 Pacific Region natural gas projection scaled to Washington population growth rate.	AEO 2010 and WA OFM population projection.	-4.0%	-2.1%	0.9%	2.9%	0.8%	0.1%
Oil Refining	2009 - 2035	2005-2008 historical growth rate of Washington's refinery throughput	EIA	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%	-0.8%

## Agriculture

Table 10 shows the annual growth rates applied to estimate the reference case projections for the agricultural sector. Emissions were projected based on the annual growth rate in historical emissions (MMtCO<sub>2</sub>e basis) for these categories in Washington for 1990 to 2007.

**Table 10. Growth Rates Applied for the Agricultural Sector**

Agricultural Category	Growth Rate	Basis for Annual Growth Rate
Enteric Fermentation	-0.1%	Historical emissions for 1990-2007.
Manure Management	1.9%	Historical emissions for 1990-2007.
Agricultural Soils	-0.4%	Historical emissions for 1990-2007.
Agricultural Burning	0.0%	Assumed no growth.

## Waste Management

Table 11 shows the annual growth rates applied to estimate the reference case projections for the waste management sector. Emissions for solid waste management and wastewater treatment were projected based on the annual growth rate in historical emissions for these categories in Washington.



**Table 11. Growth Rates Applied for the Waste Management Sector**

<b>Agricultural Category</b>	<b>Growth Rate</b>	<b>Basis for Annual Growth Rate</b>
Solid Waste Management	2.4%	Historical emissions for 1995-2007.
Wastewater Management	1.6%	Historical emissions for 1995-2007.